PCT/NZ95/00106

PAT :1

08/817445

REC'D 22 DEC 1995
WIPO PCT

IN THE PATENT OFFICE.
NEW ZEALAND

PRIORITY DOCUMENT

In the matter of the Patents Act 1953 and the Regulations thereunder.

AND

In the matter of an application for Letters Patent, numbered 264864 in the name of

DELTEC NEW ZEALAND LIMITED.

Certificate

I NATALIE JOAN GRAY Assistant Commissioner of Patents for New Zealand, Hereby Certify that annexed is a true copy of the Provisional Specification (including drawings) as filed on 4 November 1994, with an application for Letters Patent, numbered 264864 made by DELTEC NEW ZEALAND LIMITED.

AS WITNESS MY HAND THIS 30th day of NOVEMBER 1995.

Natalie Gray.

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Patents Form No. 4 Our Ref: DT/AS203610

Patents Act 1953

PROVISIONAL SPECIFICATION

A MECHANICAL DRIVE SYSTEM

We, DELTEC NEW ZEALAND LIMITED, a New Zealand company, of 64 Main Road, Tawa, Wellington New Zealand do hereby declare this invention to be described in the following statement:

PT0462394

The present invention relates to a mechanical drive system for use in the adjustment of one or more RF circuit elements. More particularly, although not exclusively the present invention relates to an adjustment drive for use in an antenna which incorporate one or more phase shifters.

In order to produce downtilt in the beam produced by an antenna array (for example a panel antenna) it is possible to either mechanically tilt the panel antenna or electrically steer the beam radiated from the panel antenna according to techniques known in the art.

Panel antenna such as those with which the present application is concerned, are often located on the sides of buildings or similar structures. Mechanical tilting of the antenna away from the side of the building increases the susceptibility of the installation to wind induced vibration and can impact on the visual environment in situations where significant amounts of downtilt are required.

In order to avoid the above difficulties, electrical beam steering can be effected by introducing phase delays into the signal input into radiating elements or groups of radiating elements in an antenna array. Such techniques are described in New Zealand Patent Specification No. 235010.

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Various phase delay techniques are known, including inserting variable length delay lines into the network feeding to the radiating element or elements, or using PIN diodes to vary the phase of a signal transmitted through the feeder network.

A further means for varying the phase of two signals is described in PCT/NZ94/00107 whose disclosure is incorporated herein by reference. This specification describes a mechanically operated variable differential phase shifter incorporating one input and two outputs.

For the present purposes it is sufficient to note that phase shifters such as those described in PCT/NZ94/00107 are adjusted mechanically by sliding an external sleeve along the body of the phase shifter which alters the relative phase of the signals at the phase shifter outputs.

A typical panel antenna will incorporate one or more phase shifters and the present particular embodiment includes three phase shifters. A signal is input to the primary phase shifter which splits the signal, each phase shifted signal is then input into a secondary phase shifter whose outputs feeds at least one radiating element. In this manner a progressive phase shift can be achieved across the entire radiating element array thus providing for a means of electrically adjusting the downtilt of the radiated beam. Other phase distributions are possible

depending on the application and directivity of the radiated beam.

While the steering action is discussed in the context of downtilt of the radiated beam, it is to be understood that the present detailed description is not limited to such a direction. Upward tilt may be produced as desired.

Another particular feature of the variable differential phase shifters is that they provide a continuous phase adjustment, in contrast with the more conventional stepped phase adjustments normally found in PIN diode or variable length delay line phase shifters.

In a panel antenna of the type presently under consideration, it is desirable to adjust the entire phase shifter array simultaneously so that a desired degree of beam tilt may be set by the adjustment of a single mechanical setting means. The mechanical drive which performs such an adjustment must result in reproducible downtilt angles and be able to be adapted to provide for a number of different phase shifter array configurations.

It is an object of the present invention to provide a mechanical drive system for use in adjusting mechanical phase shifters which mitigates the abovementioned difficulties, provides a solution to the design requirements of the antennas or antenna

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arrays described above, or which at least provides the public with a useful choice.

According to one aspect of the invention there is provided a mechanical radio frequency circuit element adjustment device for adjusting one or more radio frequency circuit elements where each element incorporates one input, one or more outputs and is adjustable by moving a first part of the circuit element with respect to a second part of the circuit element, and the first part of the circuit element incorporates the input,

the mechanical radio frequency circuit element adjustment device comprises:

a moveable carriage adapted to hold one or more primary RF circuit element;

one or more control rods adapted to:

electrically connect each output of the primary circuit element to a corresponding input of a fixed secondary circuit element, where the fixed secondary circuit elements are in fixed relation to one another; and,

provide for the movement of the carriage to be transmitted to the first parts of the secondary circuit elements;

an adjustment means adapted to:

provide a first displacement of the carriage with respect to the secondary circuit elements; and

adapted to provide for a second displacement of the

first part of the primary circuit element with respect to the second part of the primary circuit element, wherein the first and second displacements are in a fixed ratio.

The radio frequency circuit elements may be mechanical phase shifters.

The control rods may be rigid tubes adapted to contain a co-axial transmission cable.

The control rods may be substantially linear.

The adjustment means may comprise:

a compound gear which is fixed relative to the secondary RF circuit elements and comprises first and second rotatable gears fixed coaxially together;

a first gear rack fixed to the moveable first part of the primary RF circuit element and adapted to engage the first gear;

a second gear rack fixed to the carriage and adapted to engage the second gear; and

a third gear adapted to engage the first gear, so that upon rotation of the third gear the second gear produces the first displacement of the carriage and the co-rotating first gear produces the second displacement in the first part of the primary RF circuit element.

The third gear may be adapted to be manually rotated.

The third gear may be adapted to be electrically rotated.

The dimensions of the first and second gears may be adapted so that the ratio of the first and second displacements are in a fixed ratio of 1:2.

There may be one primary RF circuit element which is secured to the carriage and two secondary RF circuit elements.

The outputs of the secondary RF circuit elements may feed one or more radiating elements.

The radiating elements may be dipoles.

The adjustment means may incorporate a locking means.

The locking means may comprise a locking gear rack secured to the carriage and adapted to releasably engage the third gear where the third gear may be displaced axially so as to engage the locking gear rack.

An embodiment of the invention is now described, by way of example only, with reference to the drawings in which:

Figure 1: illustrates a schematic view of a phase shifter drive mechanism mounted on the rear face of a panel antenna.

Figure 2: illustrates a primary phase shifter incorporating a gear rack.

Figure 3: illustrates an exploded view of the adjustment assembly incorporated into the carriage.

Referring to figure 1 the rear face of a panel antenna 21 is shown. A primary phase shifter 13 is secured to carriage 10 where the outputs 15 and 16 of the primary phase shifter are in the form of rigid linear push rods extending parallel to the slideable axis of the primary phase shifter. The control rods 15 and 16 feed the input of secondary phase shifters 11 and 12 respectively. The moveable first part of the primary phase shifter is indicated by 14 and is in the form of a sliding sleeve which additionally incorporates the input which is fed by the signal conductor 22.

Secondary phase shifters 11 and 12 operate similarly, where sleeves 23 and 22 are adjusted simultaneously by the movement of the carriage 10 transmitted by the push rods 15 and 16.

Each output of the secondary phase shifters feeds a T-junction where each branch feeds a radiating element.

Upon rotation of the first gear 19 the moveable part of the primary phase shifter 14 is displaced linearly parallel to the axis of the primary phase shifter. The second gear (not shown) is fixed to the first gear 19 and engages with a gear rack secured to the carriage 10. Upon rotation of the first gear 19 the carriage 10 is displaced linearly in a direction parallel to the axis of the phase shifter. It can be seen that because of the different gear ratio between a first and second gear the relative displacements between the carriage 10 and the sleeve 14 may be fixed. The first and second gears are fixed relative to the back of the panel antenna.

Because the primary phase shifter 13 is secured to the carriage 10, upon rotation of the second gear and the resulting lateral displacement of the carriage 10, the push rods simultaneously move the first part 22 and 23 of each of the secondary phase shifters. These sleeves incorporate the secondary phase shifter input.

The main signal input cable 22 is flexible to allow for the displacement of the sleeve 14 which incorporates the input to the primary phase shifter.

First gear 19 is rotated by means of the third gear (not shown) which in a preferred embodiment is a knob marked with beam angles. The adjustment means may be locked by moving the knob and hence the third gear axially which partially disengages it

from the first gear and engages it with a locking gear rack which is secured to the adjustment means 18.

This is to avoid situations where the beam angle may wander resulting from the vertical orientation of the panel antenna combined with slippage of the sleeves 23, 22 and 14 on the primary and secondary phase shifters.

It is also envisaged that the rotation of the third gear (not shown) may be effected by a lever means, stepper motors or other techniques which are within the purview of one skilled in the art.

The linear movement of the carriage 10 and push rods 15 and 16 may be used to provide an indication of beam tilt whereby a "thermometer" style indicator may be calibrated in terms of carriage displacement versus beam tilt.

It is also envisaged that the third gear may be replaced with a worm drive in which the gear system is adapted to engage with a worm cog and drive rod extending parallel to the axis of the phase shifter.

The particular embodiment described feeds an array of eight dipoles. However, it is envisaged that adaptations of the present invention may be constructed for an array with a greater or lesser number of radiating elements.

It is to be understood that the scope of the invention is not limited to the described embodiments and therefore numerous variations and modifications may be made to these embodiments without departing from the scope of the invention.

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By their Attorneys
BALDWIN, SON & CAREY

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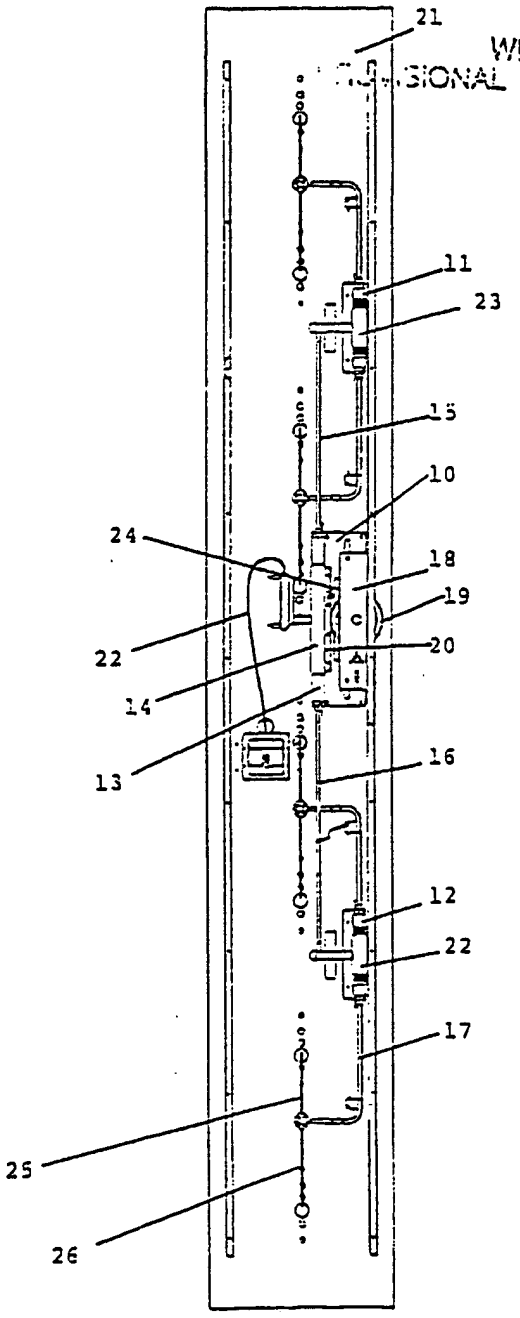

Figure 1

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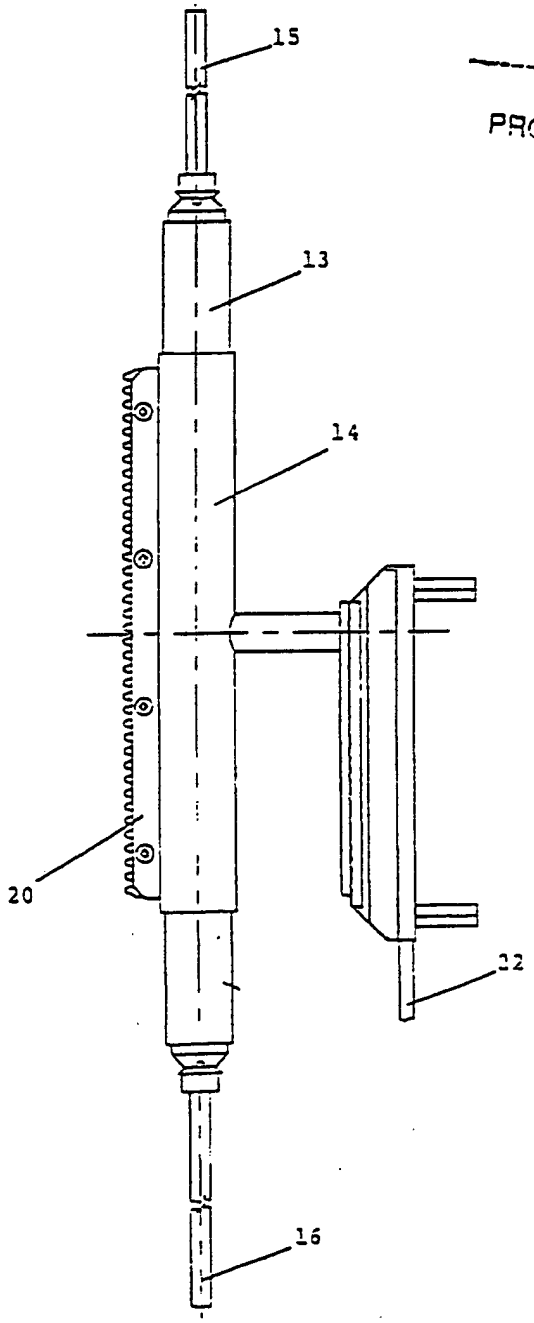

Figure 2

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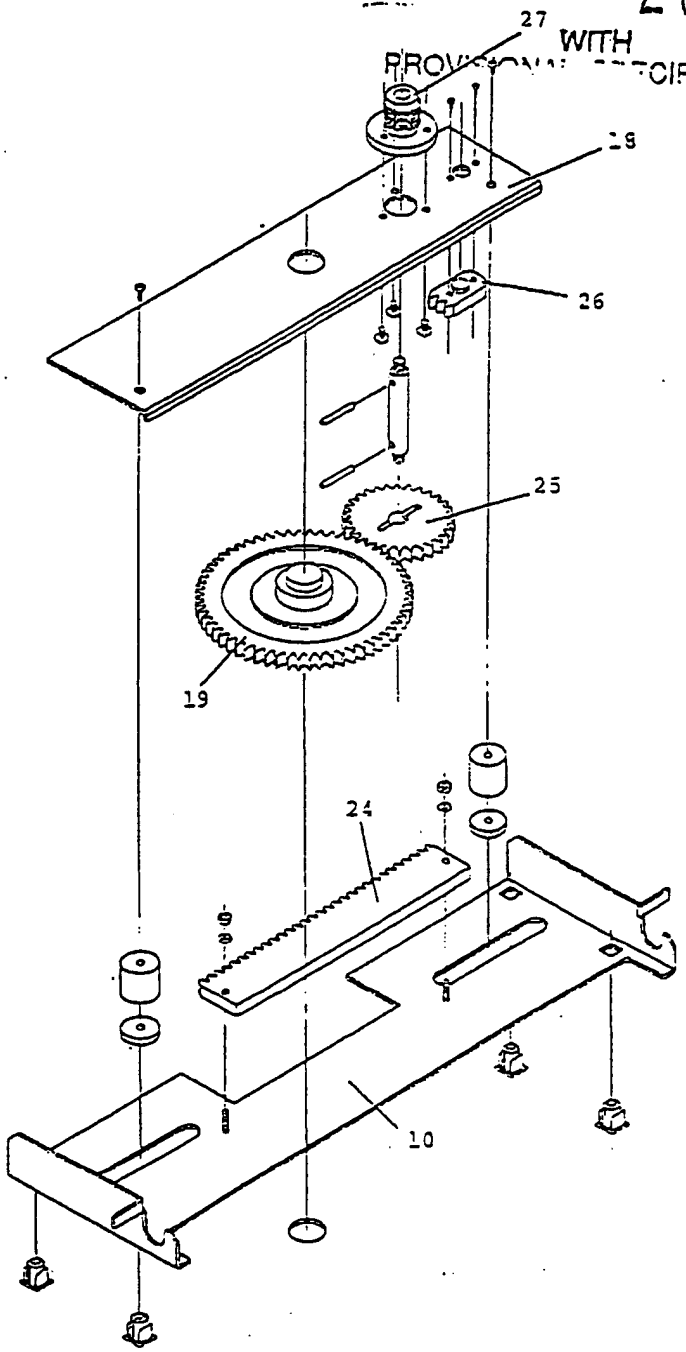

Figure 3

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